Kirkhouse Times

No. 9 June 2019

Welcome to the 9th Issue of the Kirkhouse Times which focuses on a less known programme at the Kirkhouse Trust (KT), the Stress Tolerant Orphan Legumes (STOL) consortium.

The STOL programme focuses on orphan legumes that are heat and drought tolerant, since they are needed to provide a resilient response to climate change. A number of food legumes are grown in arid regions, often on marginal land unsuitable for major crop species. Most are neglected by the major funding agencies. KT is exploring a number of crops (such as mungbean (*Vigna radiata*) and horsegram (*Macrotyloma uniflorum*) because of their heat and drought tolerant qualities, nutritional value and use by subsistence farmers.

In this issue of the Kirkhouse Times, we are introduced to our consultant for STOL, Dr Prem Mathur, and discover how STOL was established and how it has evolved. We have invited some of the African and Indian scientists who participated in the Conference on Dryland Development, held in Jodhpur last February, to share their experiences on the event. There is also a feature on the 7th STOL meeting (the first ever STOL meeting was in Arusha, Tanzania back in 2015) and on the field visits that took place also in February 2019 in Rajasthan. We hear from a PhD student from Burkina Faso that KT funded to receive drone training to support his research, in the US and we also have an update on the KT Germplasm Database.

Highlights

New STOL Consultant for the Kirkhouse Trust — *Dr Prem Mathur*

Dr Prem Narain Mathur, KT's consultant for the STOL project, is based in New Delhi, India. Here, we get to know more about him and his role within KT.

Dr Prem N Mathur

Background: Prem worked for Bioversity International for almost 21 years. Before becoming an Honorary Research Fellow in 2016, he was Bioversity International's South Asia coordinator and later acted as its regional representative for Central and South Asia. He was part of several Bioversity International global and regional project activities, which have included: promotion of the use of plant genetic resources; plant genetic resources information management and documentation; use of Geographic Information System tools for assessing and locating diversity; and the use of crop diversity for climate change adaptation. He coordinated the plant genetic resources networking activities in South Asia and the Pacific.

Prior to joining Bioversity International, he served at the Indian Council of Agriculture Research for 18 years as a Scientist, Senior Scientist and Principal Scientist; for 10 of the 18 years, he was based at the National Bureau of Plant Genetic Resources (NBPGR). He served as the national coordinator for a joint NBPGR/International Crops Research Institute for the Semi-Arid Tropics collaborative programme on germplasm collection, characterization and documentation. Prem holds a PhD degree in Plant Breeding and Genetics and was a postdoctoral fellow at the Oxford Forestry Institute, Oxford, UK.

Interests: Research and development in the field of crop genetic resources conservation and sustainable use, mainly focusing on on-farm diversification for climate change and on adaptation for small and marginal farmers' food and nutrition security in the developing world.

Role as the new KT STOL consultant: Coordinating and implementing the STOL project activities across Africa and India.

New STOL Consultant for KT Cont'd

Project plans: Under the auspices of the India Africa Framework for Strategic Cooperation, KT aims to establish a collaboration between various institutions in India and Africa to facilitate the introduction and exchange of stress-tolerant species into regions where agriculture is under pressure from climate change. The Africa-India Strategic Partnership is a multi-dimensional South-South cooperation programme and the proposed project activities are in line with the content of the India-Africa Forum Summit agreement. The Indian Government and the African Union signed a MoU/agreement, where Indian Government agreed to support African Union countries for various research and development activities, including the agricultural sector. Under agriculture, one of the agreed activities includes: sharing of improved varieties, improving the food and nutritious status of vulnerable populations, conservation of biological resources and climate smart agricultural production. Our STOL will based on these agreements and will address some of these issues.

The Genesis of the Indo-African Collaboration *Dr Prem Mathur*

Roughly 2.5 billion people (30% of the world's population) live in semi-arid regions and approximately a third of these people depend on agriculture for their food security and livelihood. Crop production in these regions has always faced challenges associated with excess heat, drought, a highly variable climate, land degradation and a loss of biodiversity, exacerbated in recent times by climate change, limited access to technology, poor market linkages, weak institutions and lack of national and international partnerships. A possible strategy to cope with climate change will be to switch from the cultivation of current crops to ones which are more drought hardy. These include a number of minor pulse species currently being grown to a limited extent in the drier regions of both Africa and Asia, thereby providing a measure of food and nutritional security to households, as well as some income to farmers. The species have remained relatively neglected by both researchers and industry because of their limited economic importance in the global market.

KT, which since 2005 has supported a number of pulse breeding projects across both India and sub-Saharan Africa, has recently initiated its "Stress Tolerant Orphan Legumes" (STOL) programme, aiming to promote the use of minor pulses (https://www.kirkhousetrust.org/stolprojects). While most of its investment to date has been targeted at cowpea (in West Africa), common bean (in East Africa) and dolichos (in South India), it has also been supporting a domestication programme for the highly drought tolerant African species *Tylosema esculentum* (marama bean) in Namibia. Recognizing that little has been done to assess the relative response of pulse species to the higher levels of stress expected as a result of climate change, the STOL programme was launched at a workshop at the Nelson Mandela African Institute of Science and Technology in Tanzania in 2015. The outcome of this meeting was the identification of an inventory of species for evaluation: this comprised cowpea (*Vigna unguiculata*) as the reference crop; moth bean (*Vigna aconitifolia*); mung bean (*Vigna radiata*); horsegram (*Macrotyloma uniflorum*); dolichos (*Lablab purpureus*); bambara groundnut (*Vigna subterranean*); marama bean; tepary bean (*Phaseolus acutifolius*); rice bean (*Vigna umbellata*); pigeonpea (*Cajanus cajan*); lima bean (*Phaseolus lunatus*); adzuki bean (*Vigna angularis*) and common bean (*Phaseolus vulgaris*). To determine the potential of these species to perform in stressful conditions, it was necessary to establish a framework allowing seed to be easily shared between the participants.

To resolve the institutional difficulty associated with seed exchange between India and African countries and *vice versa*, the project took advantage of a recently established Africa-India Strategic Partnership agreement, a multi-dimensional South-South cooperation arrangement. A memorandum of understanding was concluded between KT and the Indian Council of Agricultural Research-National Bureau of Plant Genetic Resources (ICAR-NBPGR). Under this agreement, currently nine African countries (Burkina Faso, Ghana, Kenya, Mali, Namibia, Niger, Nigeria, Tanzania and Uganda) and India have agreed to collaborate in a number of activities, namely: (i) to identify a panel of fifty accessions of each STOL species; (ii) to multiply and distribute this seed to the various partners for evaluation; (iii) to carry out farmer field trials of the best performing species/accessions; (iv) to train extension workers and farmers in the management of unfamiliar crops; (v) to strengthen and establish local seed systems through capacity building and the setting up of community-based seed storage facilities; and (vi) to support DNA fingerprinting activities directed at the STOL species at ICAR-NBPGR. The duration of the project, jointly implemented by KT and ICAR-NBPGR, will be for five years starting May 2018.

The 13th International Conference on Development of Drylands

The 13th ICDD took place in February 2019, in Jodhpur, India. KT and the Central Arid Zone Research Institute (ICAR) co-sponsored a Satellite Symposium entitled:"Arid Agro-ecosystems: Challenges and Opportunities". We have invited 5 participants who were supported by KT to comment on the event.

"Participating in the 13th International Conference on Dryland Development at Jodhpur, India, was an invaluable opportunity to share experiences and to learn from others. I learnt a lot about the urgent need to regenerate degraded land, and what ways and means can be used to achieve this. During the conference, I was happy to share with an honourable assembly our experience by presenting my talk "Achievements so far under STOL based on experimentation in Burkina Faso and Tanzania.

The 13th ICDD cont'd

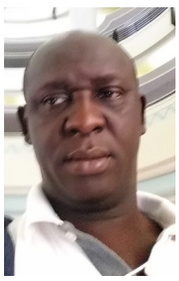
In the frame of the conference's overall topic of "Converting dryland areas from grey to green", various speakers from around the world shared their experience and our attention was particularly drawn to the integrative approach based on the use of big data, using meteorological data, information about available crop varieties and genotypic information, in order to improve current germplasm and to aid in the introduction of new crop varieties. Various measures can be applied to help revive arid lands and thus increase the resilience of local vulnerable populations. This integrated approach using modern tools such as drone imagery in phenotyping, as well as modern biotechnologies including gene editing to enhance the adaptation of dryland crops has great potential to generate beneficial outcomes. Finally, the stay in Jodhpur was enriched by a visit to the Central Arid Zone Research Institute (CAZRI) where a number of ongoing experiments and irrigation facilities were demonstrated, and the visit to the proposed STOL sites at Nagore, Samdari and Keshwana research stations. I would like to extend my sincere gratitude to the Kirkhouse Trust SCIO, to Dr. Prem Mathur and the International Dryland Development Commission (IDDC) for allowing us to attend this important meeting."

Felicien Zida, final year PhD Student, Lab Manager at INERA, Burkina Faso

"The 7th STOL meeting was organised on 14 February 2019 as a satellite session. The objective was to finalize measures to implement the STOL project in both India and the various African partner countries. The 17 participants present represented national organisations from India, Burkina Faso, Namibia, Ghana, along with the Kirkhouse Trust team. After welcoming the participants on behalf of the director of NBPGR Dr Kuldeep Singh, I explained the procedure required to access legume species germplasm from India. In my presentation I gave an overview of the number of crops to be sent, the number of accessions per crop, the preferred design of trials and the amount of seed required. Duly signed copies of the necessary MTAs have now been received from eight partner countries and letters seeking the approval of DARE have been sent. Seed of mungbean, mothbean, cowpea, horse gram and dolichos have been received by NBPGR from the Indian partners and are currently being packaged for dispatch and testing in eight locations."

Dr Pratibha Brahmi, Principal Scientist and Officer In-Charge at ICAR-NBPGR, India

"I would like to first of all express my profound gratitude to Kirkhouse Trust SCIO for the sponsorship offered to me to participate in the 13th International Conference of Dryland Development (13th ICDD) in Jodhpur India. My presence at the conference gave me opportunity to share with the participants the achievement of the KT sponsored Seed Dissemination project at SARI, Ghana. Most of the participants I interacted with after my presentation could not hide how they agree in the approach being used by the project to sustainably promote access to improved seeds by farmers. My participation at the conference also created an opportunity for me to learn from the quality presentations of eminent scientists who were either Ministers, Chairs, Director Generals, Chairmen or Presidents of relevant institutions related to dryland and development. Most of the topics were thought-provoking and gave me much insight into climate change, its effects and as well challenged me as a scientist to do more to contribute to the global fight against climate change and its effects on humanity. The 13th ICDD also presented a fertile ground for networking to establish collaborations that could developed into long-time working teams."



Dr Francis Kusi, Senior Research Scientist SARI, Ghana

"The satellite symposium entitled "Arid Agroecosystem: Challenges and Opportunities" co-organised by Kirkhouse Trust and AZARI featured a review of the existing status of natural resources in dry land areas, and discussed possible ways forward. The Kirkhouse Trust-sponsored project "Stress Tolerant Orphan Legumes" (STOL) is one the initiatives being undertaken to mitigate the impacts of climate change, both in terms of nutritional security and the promotion of new crops and/or new varietal diversity to farmers based in semi-arid regions in both Africa and India. The STOL species are generally under-recognised with respect to their value *per se*, their importance in the context of diversification and their potential complementation of other foods. They are better adapted than are the major legume crops to extreme soil and climatic conditions, in particular with respect to their ability to tolerate drought and high air temperature. Making available varieties of one or more of the STOL crops able to thrive under semi-arid conditions would make a significant contribution to household food and nutritional security in these regions."

Dr Jai C Rana, National Coordinator UN Environment-GEF Project India

The 13th ICDD cont'd

"The conference was well organised with good plenary and parallel sessions and I enjoyed meeting and networking with many scientists. It was a melting pot for specialists in arid agricultural sciences. I had several interesting and informative discussions with a number of the conference delegates, including members of the STOL consortium, some CGIAR centre directors, fellow University professors and lecturers and Indian scientists (who represented the majority of the delegates). In particular, I met scientists seeking collaborations with Namibia and I hope that something will come out of some of these discussions. The presentation by Prof. Dr Michael Reid on the fact that 30% of world food is lost post-harvest, and that 40% of what remains is compromised by aflatoxin was a stand-out paper, which has led me to think of writing a review paper on redefining food and food shortage. Of important mention was the field trip experience with the STOL team to the research stations in Rajasthan. My presentation, "Domestication efforts of *Tylosema esculentum* (Marama bean), an orphan legume, as a dryland crop alternative in Namibia" summarised ten years work and current seed multiplication work. I was proud that I narrated through the slides and hopefully left people with one or two messages regarding the appropriateness of galvanizing efforts in developing marama bean as a dryland-adapted crop for now and the future whether for food or for cash. "

Professor Percy Chimwamurombe, Professor of Biology and Deputy Head of Department, NUST, Namibia

7th STOL Meeting and Field Trips in India to locate potential STOL sites

Drs Claudia Canales and Robert Koebner

Samdari field site with its beach sand-like soil

On the morning of February 15th, a small group of us set off from Jodhpur to visit potential field sites for Indian component of the STOL project: Ed Southern, Robert Koebner, Prem Mathur, Jai Rana, Percy Chimwamurombe, Felicien Zida and Claudia Canales. The STOL project aims to establish the potential of currently under-utilized legumes, many of which are native to India, to cope with hot and dry environments in Africa. The present list of species comprises horsegram, moth bean, dolichos, marama bean; rice bean, bambara groundnut, tepary bean, pigeonpea and mung bean, and their performance will be compared to that of cowpea, which is presently a hugely important crop in the Sahel. While the STOL species are seen as potential replacements for cowpea if the climate continues to warm, they could also represent an option for marginal soils currently not cultivated in the Sahel, or be used as components of a crop diversification strategy to mitigate weather-related risks. Since new (to a farming household) crops have to satisfy additional requirements, such as taste and cooking time, these characteristics will also be assessed by the project.

Samdari site being visited by the group of delegates

The first phase of the project involves the multiplication of sufficient seed quantities for 50 accessions of each of the STOL species in order to support the intended field trials in multiple locations across Africa and India. For this reason, the multiplication sites must have irrigation facilities to ensure crop survival in case of insufficient precipitation. The first site we visited was the Rajasthan Agricultural University outstation at Samdari, located between Jodhpur and Barmer. The soil looked like beach sand! The area is surrounded by a wall (to exclude animals) and has the facility to extract water from a 90 m deep bore hole. It is equipped with a small building which doubles up as both a temporary seed store and an equipment shed. A small contingent of staff (scientific and technical) and students work at the site.

The second site is at Keswana-Jalore, also belonging to Rajasthan Agricultural University. This is a much more substantial and developed operation, established in 1988. The whole area is enclosed by a wall, and it has the capacity to raise crops under irrigation, unlike Samdari. We saw a range of crops growing, including chickpea, various Brassica spp. and water cress (grown as a medicinal plant), but no STOL species. The site includes a number of buildings, including a laboratory, offices and accommodation.

Jalore site is more established but has no STOL crops

7th STOL Meeting and Field Trips cont'd

On February 16th we visited a site close to Jaisalmer, where the average annual rainfall is very low (100 -150 mm) and quite unreliable. The local farmers grow subsistence crops of wheat, mustard and chickpea using a traditional water capture system called "khadeen", which uses a natural or an artificially created slope to funnel rain into a bunded ponding area, where it seeps into the soil to provide the moisture needed for crop to be grown after the rainy season is over. The size of the khadeens varies from relatively modest to large enough to provide enough land to be cropped by a number of farmers. The crops we saw were impressively vigorous and free of any disease. This is however not the area where STOL crops would be tested, which we did not see since at the at the time it was only a flat bit of empty land.

Jaisalmer site experiences low rainfall

Drone Training at University of California, Davis

Felicien Zida

During July 2018, I received training at UC Davis, California, from Travis Parker, on the use of drones for data collection. The training was supported by the Kirkhouse Trust, with the collaboration of Professor Paul Gepts. After studying theoretical aspects of the uses of UAVs in agriculture, the rules governing their use, safety aspects (not flying above 120m or near an airport *etc.*), I learned how to launch, fly (using DGI Go and Ground Station-Pro) and land a UAV, along with managing data collection.

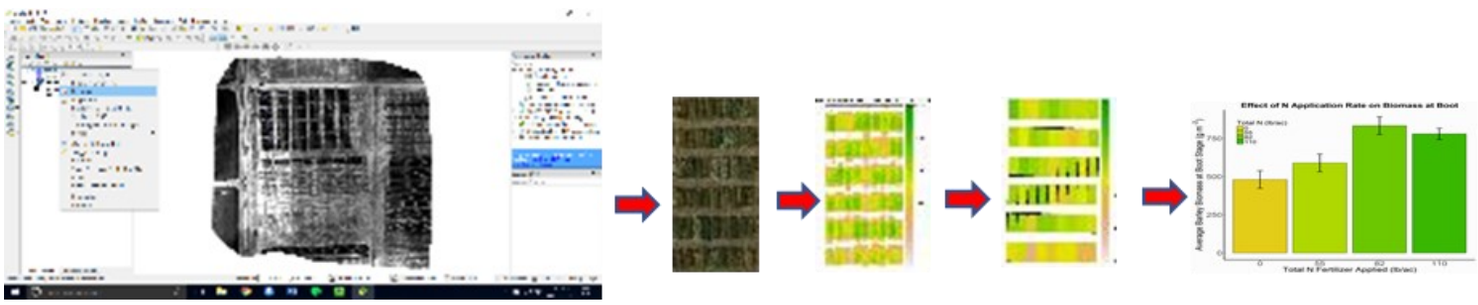
There are two options to plan a flight for data collection:

1. Choosing four points in each corner of the field and then mapping the area with the app (Aircraft mode)
2. Using Google Maps to delimit the area to be covered (Tap mode)

The images taken by the camera during the flight are then processed and analysed using Pix4D software.

Mosaic of Pictures **software** **Fields after assembling**

After assembling images, the QGis application processes the images obtained and extracts the data necessary for the statistical analysis of various parameters, such as canopy cover, the number of plants present and the physiological condition of the plants.



Data extraction and analysis through QGIS

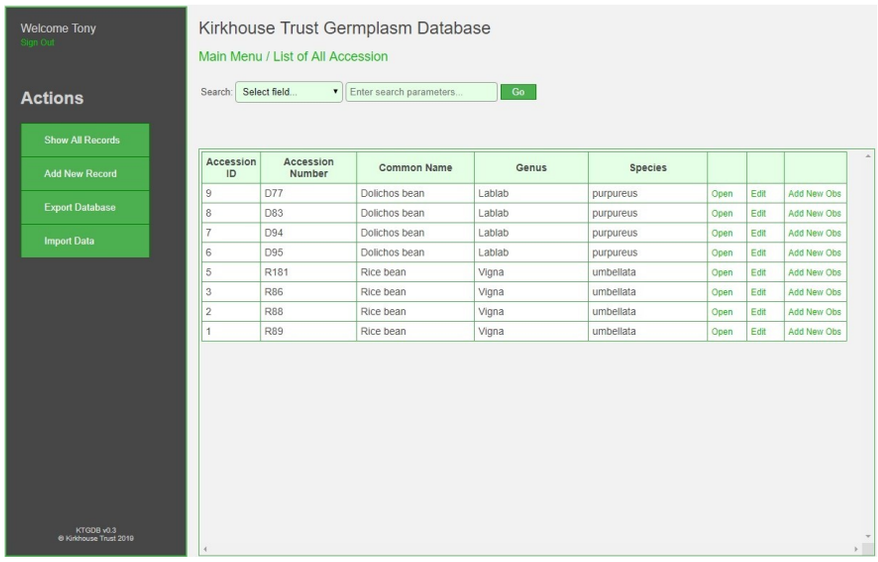
Special thanks are due to the Kirkhouse Trust and UC Davis for supporting my training in using such a useful tool!

The Kirkhouse Trust Germplasm Database (KTGDB) *Antony Bowes*

Antony Bowes is developing a database designated as the "Kirkhouse Trust Germplasm Database" (KTGDB), with a view to promoting the centralised storage of germplasm information collected by projects working under the STOL umbrella. KTGDB has been designed to accept both quantitative and qualitative data, and its central location will allow for the seamless sharing of data sets between STOL participants.

As it is based on a simple MySQL database, with its front-end built using Hypertext Preprocessor (PHP), users will benefit from a quick, easy-to-use and readily accessible database, which can be both read and updated simultaneously by multiple users. KTGDB has been designed so that STOL partners can collect their data out in the field with no requirement for internet access, and upload the data to the database at a site once they reach a location with internet access. Several features have been incorporated to aid in managing the data. For example, it will be possible to see who has entered a particular datapoint, and restrict editing permissions on datasets.

KTGDB is still in development – we are aiming to release it to users towards the end of 2019. A screenshot showing how the data will appear is shown in the image to the right.



Special Mentions : Graduations

Very well done to **Ombaka Joseph Orende** from University of Nairobi who graduated with an **MSc** in August 2018. His thesis is titled: "Drought tolerance in Andean and Mesoamerican genotypes of the common bean".

Congratulations **Tamara Miller** from UC Davis who has graduated with a **PhD** in March 2019 with a thesis titled : "Toward Genomics-Based Breeding in Phaseolus vulgaris and Quantitative Trait Locus Mapping of Angular Leaf Spot Resistance ".

Congratulations to **Gilles Ibie Thio** who graduated with a **PhD** at Université Ouagadougou on 25th October 2018 with a thesis titled: "Etude génétique de la résistance du niébé (*Vigna unguiculata (L.) Walp.)* à la maladie des taches brunes causeé par *Colletotrichum capsici* (Syd.) Butler et Bisby au Burkina Faso".

Congratulations to **Melese Lema** for graduating in March 2019 from Hawassa University with an **MSc** with a thesis titled : "Introgression of genes conferring resistance against angular leaf spot (*Pseudosercospora griseola*) and anthracnose (*Colletotrichum lindemuthianum*) in to common bean (*Phaseolus vulgaris L*) advanced line using marker assisted selection".

Very well done to **Annet Namusoke** who has graduated with an **MSc** in January 2019 from Makarere University. Her thesis is titled: "Identification and validation of codominant molecular markers for selection of anthracnose disease resistance in common bean".

Many thanks to all our contributors for this issue of the Kirkhouse Times.

Dr Cynthia Sam (Kirkhouse Trust)

Editors : Drs Robert Koebner and Claudia Canales